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Patent No. 6,988,042
Request for Cert. of Correction dated April 10, 2006
Attorney Docket No. 4366-032255

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent No.	:	6,988,042 Confirmation No. 7157
Inventor	:	Choi et al.
Issued	:	January 17, 2006
Title	:	Method for Detecting Line-to-Line Fault Location in Power Network
Examiner	:	Toan M. Le
Customer No.	:	28289

REQUEST FOR CERTIFICATE OF CORRECTION OF PATENT
FOR PTO MISTAKE (37 C.F.R. 1.322(a))

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

ATTENTION: Decision and Certificate of Correction Branch
Patent Issue Division

Sir:

In accordance with 35 U.S.C. §254, we attach hereto Form PTO/SB/44 and a copy of proof of PTO's error and request that a Certificate of Correction be issued in the above-identified patent. The following error appears in the patent as printed:

Column 7, Line 17, Claim 4. "If" should read -- I_f --

Respectfully submitted,

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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

(Also Form PTO-1050)

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO.	:	6,988,042
APPLICATION NO.	:	10/722,089
ISSUE DATE	:	January 17, 2006
INVENTORS	:	Choi et al.

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 7, Line 17, Claim 4. "If" should read -- I_f --

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APR 17 2006

METHOD FOR DETECTING LINE-TO-LINE FAULT LOCATION IN POWER NETWORK

BACKGROUND OF THE INVENTION

(a) Field of the invention

The present invention relates to a method for detecting a line-to-line fault location in power network, and more particularly, detecting the line-to-line fault location with direct 3-phase circuit analysis without using a symmetrical component transformation, whereby even in an unbalanced 3-phase circuit the line-to-line fault location can be accurately detected.

(b) Description of the Related Art

Rapid growth of economy has resulted in large scale of power systems, and an excessive increase in transmission and distribution networks of electric power systems causes many kinds of faults by various causes. Transmission and distribution networks of electric power systems are playing very important roles as the links between the power suppliers and the consumers. However, because most of lines are exposed to air, lightning, contact of animals or mal-functioning of protection devices causes many kinds of faults. When a line-to-line fault occurs, detecting a fault location rapidly and precisely separating the part of the network including the fault location from the rest part of the network until repairing the fault being finished is very important to minimize power interruption rate and to provide highly reliable power supplying service and electric power of high quality.

Transformation of 3-phase networks to symmetrical component systems (symmetrical component transformation) is generally used in conventional methods for detecting the line-to-line fault locations. A 3-phase balanced network can be transformed to a symmetrical component system, which has no coupling between sequences so that the systems of equation may be solved easily. In other words, diagonal sequence impedance matrices are obtained in case of the balanced networks, thus sequence voltage and current can be expressed without any coupling among the sequences.

The advantage of the above method is that it can be easily applied to a balanced network. Zero sequence, positive sequence and negative sequence can be easily analyzed because they are not correlated, that is, there is no couplings, or equivalently, mutual impedances among

WHAT IS CLAIMED IS:

1. A method for detecting a line-to-line fault location in a power network comprising the steps of:

determining elements of a line impedance matrix and a load impedance matrix, and phase voltages and currents at a relay;

determining a line-to-line fault distance d by substituting said elements of said line impedance matrix and said load impedance matrix, and said phase voltage and current into a fault location equation based on direct circuit analysis;

wherein said fault location equation is derived from a model consisting of said phase voltage and current at the relay, a fault current, a fault resistance and the line-to-line fault distance;

wherein the model is based on the line-to-line fault between a-phase and b-phase and described by a model equation:

$$V_{Sa} - V_{Sb} = (1-d)((Zl_{aa} - Zl_{ba})I_{Sa} + (Zl_{ab} - Zl_{bb})I_{Sb} + (Zl_{ac} - Zl_{cb})I_{Sc}) + I_f R_f,$$

where, $V_{Sabc} = [V_{Sa} \quad V_{Sb} \quad V_{Sc}]$: phase voltage vector, $I_{Sabc} = [I_{Sa} \quad I_{Sb} \quad I_{Sc}]$: phase current vector, $Zl_{abc} = \begin{bmatrix} Zl_{aa} & Zl_{ab} & Zl_{ac} \\ Zl_{ba} & Zl_{bb} & Zl_{bc} \\ Zl_{ca} & Zl_{cb} & Zl_{cc} \end{bmatrix}$: line impedance matrix, I_f: fault current, 1-d: fault distance;

wherein said fault location equation is derived by using the matrix inverse lemma: $(A^{-1} + BCD)^{-1} = A - AB(C^{-1} + DAB)^{-1} DA$, to simplify an inverse matrix calculation; and

wherein the fault location equation is derived by direct circuit analysis without using the conventional symmetrical component transformation method.

2. The method of claim 1, wherein the power network is a 3-phase balanced network.

3. The method of claim 1, wherein the power network is a 3-phase unbalanced network.

4. The method of claim 1, wherein the fault location equation is derived by steps of:

(a) expressing the fault current I_f in terms of the phase current vector I_s by using current distribution law of a parallel network yielding:

$$\begin{bmatrix} I_f \\ 0 \\ 0 \end{bmatrix} = Y_f [Y_f + (dZl_{abc} + Zr_{abc})^{-1}]^{-1} \begin{bmatrix} I_{Sa} \\ I_{Sb} \\ I_{Sc} \end{bmatrix}, \text{ where } Y_f = \begin{bmatrix} 1/R_f & -1/R_f & 0 \\ -1/R_f & 1/R_f & 0 \\ 0 & 0 & 0 \end{bmatrix}: \text{ fault}$$